2. OU 3-14 BACKGROUND AND OPERATIONAL HISTORY

Operable Unit (OU) 3-14 is located in the northern portion of the Idaho Nuclear Technology and Engineering Center (INTEC), and OU 3-14 release sites are grouped in three categories (see Figure 2-1):

- Tank Farm soil sites are located within the Tank Farm boundary (DOE-ID 1999a) in the north-central portion of INTEC. All of the soil sites are consolidated into site CPP-96.
- The former INTEC injection well (site CPP-23) is southwest of the Tank Farm..
- Three additional sites from OU 3-13: CPP-61, CPP-81, and CPP-82, are also southwest of the Tank Farm, north and west of site CPP-23. These three sites from OU 3-13 were screened as no further action sites in the OU 3-13 RI/FS. They were assigned to OU 3-14 in the OU 3-13 record of decision (ROD) (DOE-ID 1999b) because the U.S. Department of Energy Idaho Operations Office (DOE-ID), U.S. Environmental Protection Agency (EPA), and Idaho Department of Environmental Quality (IDEQ) determined that data for the sites used in the OU 3-13 RI/FS were inadequate to make remediation decisions, as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Because only a data review of these no further action sites will be conducted as part of Phase I activities (see Section 1.3), these activities will not be addressed further in this section.

2.1 Tank Farm

Essentially all of the high-level waste at the Idaho National Engineering and Environmental Laboratory (INEEL) exists at INTEC, formerly the Idaho Chemical Processing Plant (ICPP) (Palmer et al. 1998). INTEC reprocessing of spent nuclear fuel (SNF) was conducted from 1953 to 1992. Two types of liquid waste have been stored at the Tank Farm; they are high-level liquid waste (HLLW), sometimes termed non-sodium bearing waste, and sodium–bearing waste. The HLLW was generated as a direct result of reprocessing SNF and the sodium–bearing waste was generated from incidental activities, such as decontamination, associated with operation of INTEC. The liquid sodium–bearing waste is stored and treated in the same manner as the HLLW. In April 1992, the U.S. Department of Energy (DOE) announced that SNF would no longer be reprocessed and called for a shutdown of the reprocessing facilities at INTEC. Since that time, no more HLLW has been (or will be) generated. The production of sodium–bearing waste is dependent on how much and what type of work is done at INTEC in the future, especially in the area of decontamination and decommissioning.

From 1953 until INTEC calcination activities began, the high-level liquid waste from fuel dissolution and extraction reprocessing activities accumulated in the Tank Farm underground stainless steel tanks. From 1963 until 1981, the liquid waste was stored temporarily in the Tank Farm and was then transferred to first Waste Calcining Facility (CPP-663). After 1981 until June 2000, Tank Farm waste was shipped to the New Waste Calcining Facility (NWCF; CPP-659). The calciner currently is closed while DOE-ID is deciding whether to reapply for an operations permit or to permanently close the facility and replace it with another waste treatment facility.

Today there is no widespread agreement about what precisely constitutes high-level waste. For example, the U.S. Nuclear Regulatory Commission defines high-level waste as waste resulting from first-cycle extraction activities (10 CFR 61); the DOE defines high-level waste as "the highly radioactive waste material resulting from the reprocessing of SNF, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations and other highly radioactive material that it is determined, consistent with existing law, to require permanent isolation" (DOE Manual 435.1). Using the DOE definition, second- or third-cycle extraction waste and, therefore, sodium–bearing waste could conceivably be considered

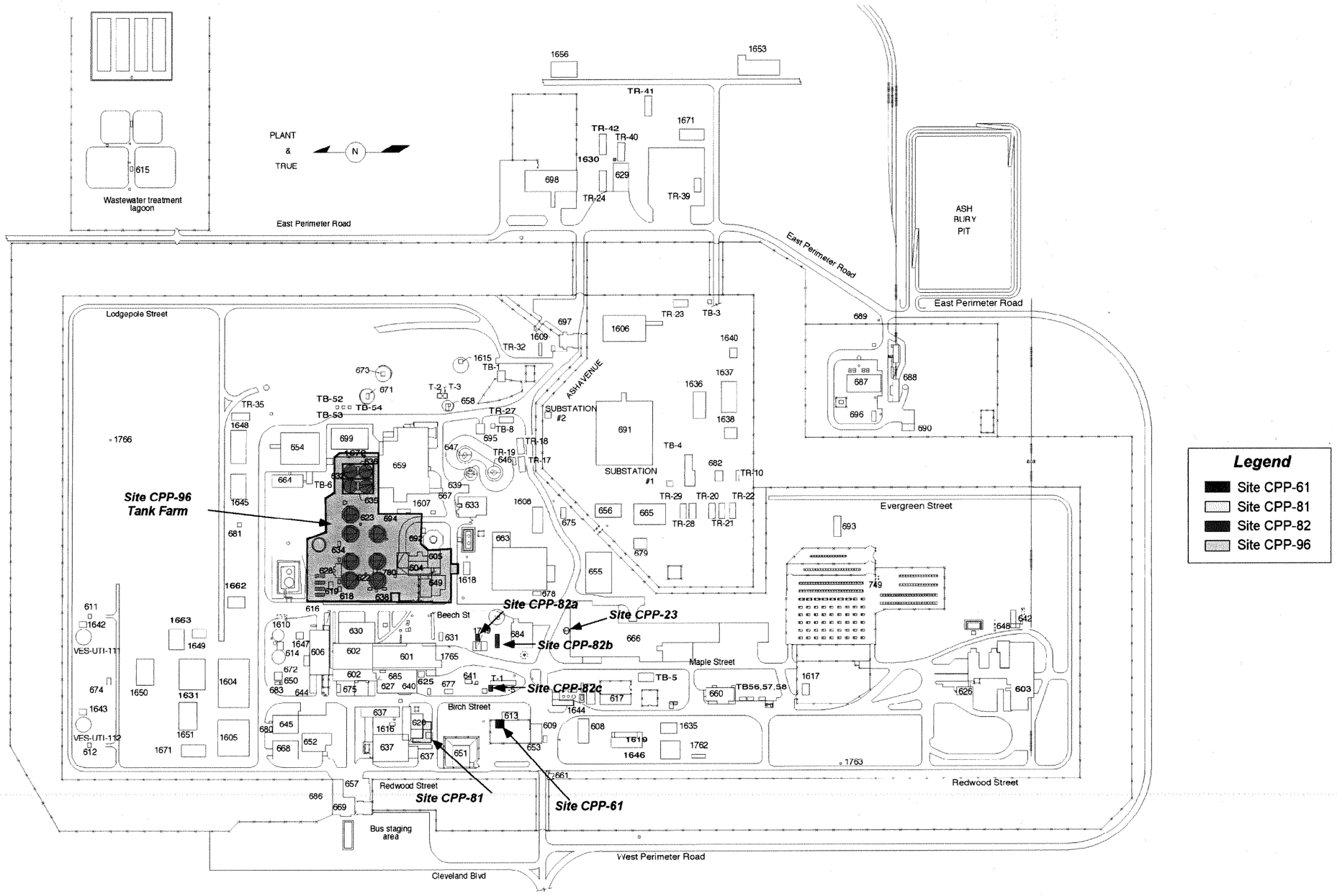

Figure 2-1. Physical layout of the Idaho Nuclear Technology and Engineering Center showing the Tank Farm, the former INTEC injection well, and three additional sites from OU 3-13, Sites CPP-61, CPP-81, and CPP-82.

high-level waste. However, historically at the INTEC, operationally-based definitions were used to describe the types of waste produced at the INTEC fuel processing building (CPP-601) and stored at the Tank Farm:

- **High-level waste**— High-level waste, generated as a direct result from reprocessing SNF during first-cycle extraction (Wichmann, Brooks, and Heiser 1996)

- **Sodium-bearing waste**— or non-high-level waste from second- and third-cycle extraction and from incidental activities, such as decontamination associated with operation of INTEC (Palmer et al. 1998; Wichmann, Brooks, and Heiser 1996). In the past, sodium–bearing waste was called intermediate-level waste. Sodium-bearing waste typically contains no more than about 10% of the radioactivity of high-level waste. Sodium-bearing waste cannot be calcined directly in NWCF because the waste, nearly 100 times higher in sodium content than high-level waste, forms alkali compounds during the calcination process that melt at calcination temperatures and cause the calciner's fluidized bed to agglomerate. The high levels of potassium and manganese in the waste also clogged the calciner. Sodium-bearing waste is first concentrated in the high-level liquid waste evaporator or blended with reprocessing waste or non-radioactive materials, such as aluminum nitrate, before calcination (Palmer et al. 1998; Wichmann, Brooks, and Heiser 1996).

Other radioactive liquid waste was processed through the process equipment waste (PEW) evaporator. Until 1984, the overheads from this waste were sent to the INTEC injection well (Site CPP-23) and then to the percolation ponds until December 31, 1991. After January 1, 1992, the waste was sent to the Liquid Effluent Treatment Disposal Facility and then released to the environment through the main stack (CPP-708).

With the end of the cold war and the diminishing need to recover and recycle SNF, DOE announced the discontinuation of the reprocessing mission at INTEC in April 1992. Since the discontinuation, no more high-level waste has been generated at INTEC. The decontamination and decommissioning of the final second- and third-cycle campaigns, completed in 1994, generated sodium-bearing waste. Since this time, INTEC operations have shifted to continued management and disposition of waste accumulated from previous reprocessing activities. Until 1998, the facility was designated the Idaho Chemical Processing Plant, at which time it was redesignated the Idaho Nuclear Technology and Engineering Center in keeping with the current emphasis of waste management and storage of SNF, high-level waste, and sodium-bearing waste.

The 1995 *Settlement Agreement* (DOE 1995) between DOE, the State of Idaho, and the U.S. Navy required calcination of all the high-level waste at the Tank Farm by June 1998, which was achieved in February 1998 (Hovinga 1998). However, the heel of Tank WM-188 has not been flushed; therefore, it is residual high-level waste. A heel is defined as the liquid volume remaining in the tank after it has been reduced to the greatest degree possible with existing tank transfer equipment (Rasch 1994).

The *Settlement Agreement* requires treatment of all sodium–bearing waste at the Tank Farm by December 31, 2012.

The remaining waste at the Tank Farm is sodium–bearing waste, which has been managed as high-level waste, but is actually mixed transuranic (TRU) waste. Transuranic waste is defined as radioactive waste containing any alpha-emitting radionuclide with an atomic number greater than 92, a half-life longer than 20 years, and a concentration greater than 100 nCi/g at the end of an assumed period of 100 years of institutional control (DOE-ID 1996). However, a waste incidental to reprocessing (WIR) determination is required for the sodium–bearing waste at the Tank Farm to be managed as TRU waste.

The WIR determination is based on guidance in U.S. DOE Order 435.1, DOE Manual 435.1, and DOE Guidance 435.1, which would be the final determination for allowing management of all the Tank Farm waste, including the heels (flushed or not flushed), as incidental waste (LMITCO 1999a). Closure of the tanks cannot commence until DOE approves the WIR determination. The ultimate classification of the waste is important because all high-level waste must be permanently isolated in a geologic repository, such as Yucca Mountain. Management of the waste as TRU waste provides more management options after treatment, such as storage at the Waste Isolation Pilot Plant, at the Hanford Site, or at any other approved TRU waste storage facility.

Low-level liquid waste (10 CFR 61.55) is generated at INTEC by a variety of processes such as off-gas treatment, facility decontamination, laboratory operations, and equipment decontamination, and is sent to the Tank Farm. Currently, the Tank Farm is used for the interim waste storage of liquid mixed waste (radioactive and hazardous) before calcination. Because the Tank Farm stores mixed waste, it is regulated as an interim status tank system (LMITCO 1999b) under the Hazardous Waste Management Act (HWMA) of 1983 (IC § 39-4401) and the Resource Conservation and Recovery Act (RCRA) (42 USC § 6901 et seq.; LMITCO 1998a; Gilbert and Venneman 1999).

The chronological construction and upgrade/improvement/repair history of the Tank Farm and ancillaries is summarized in Appendix F of this Work Plan. In 1977, a 0.02-in.-thick Dupont Polyolefin 3110 membrane was placed over the Tank Farm's graded surface to prevent water ingress from the surface. The membrane at that time was stated to be sandwiched between two 3-in. sand layers. The sand-Polyolefin-sand layers were then covered with 3 in. of gravel. More recent descriptions, from Track 2 reports, indicate that the membrane is sandwiched between two soil layers, that is, 0.6 m (2 ft) of soil beneath the membrane, the 0.5 mm (20-mil) thick membrane liner, and an additional 15 cm (6 in.) of soil to prevent the membrane liner from blowing away. Although the existing Tank Farm membrane's integrity may have been compromised during operational repairs and upgrades, the Group 1 interim action anticipates leaving the existing membrane in place.

The Tank Farm comprises nine 300,000-gal (WM-182 through WM-190) and two 318,000-gal active stainless steel tanks contained in concrete vaults (WM-180 and WM-181) 13.7 m (45 ft) belowgrade, and four inactive 30,000-gal stainless steel tanks (WM-103 through WM-106), also belowgrade. Previously, three 18,000-gal PEW tanks (WM-100, WM-101, and WM-102) and the associated valve boxes, encasements, and piping (LMITCO 1999a, 1998a) were considered as part of the Tank Farm system. However, these tanks, located within the Waste Treatment Building (CPP-604), may continue to operate to support INTEC operations after the Tank Farm is closed. The three PEW tanks, along with five support tanks (WL-101, WL-102, WL-132, WL-133, and a new tank, WL-111) will be permitted as part of the PEW system and, therefore, are no longer considered part of the Tank Farm system.

Over the next several years, DOE will close the eleven 300,000-gal and the four 30,000-gal underground tanks within the Tank Farm because (1) reprocessing has been terminated and (2) the tanks do not comply with RCRA secondary containment requirements, and the high-radiation fields within the Tank Farm greatly impede bringing the tanks into compliance. In addition, because the concrete vaults of the eleven 300,000-gal tanks have no access, they cannot readily be inspected to certify either compliance with RCRA secondary containment requirements or current seismic standards (see Section 2.1.1.3). The tanks have never leaked and their estimated remaining life (970 years) greatly exceeds the length of time of their remaining use (Palmer et al. 1999). All the tanks are scheduled to be closed by 2017 (see Section 2.1.2). An aerial and a conceptual view of the Tank Farm are provided in Figures 2-2 and 2-3, respectively. Because PEW operations may continue after the Tank Farm is closed, the PEW 18,000-gal tanks are not part of the Tank Farm closure and will be permitted as part of the PEW system (LMITCO 1999a). These eight tanks are not discussed further in this Work Plan.

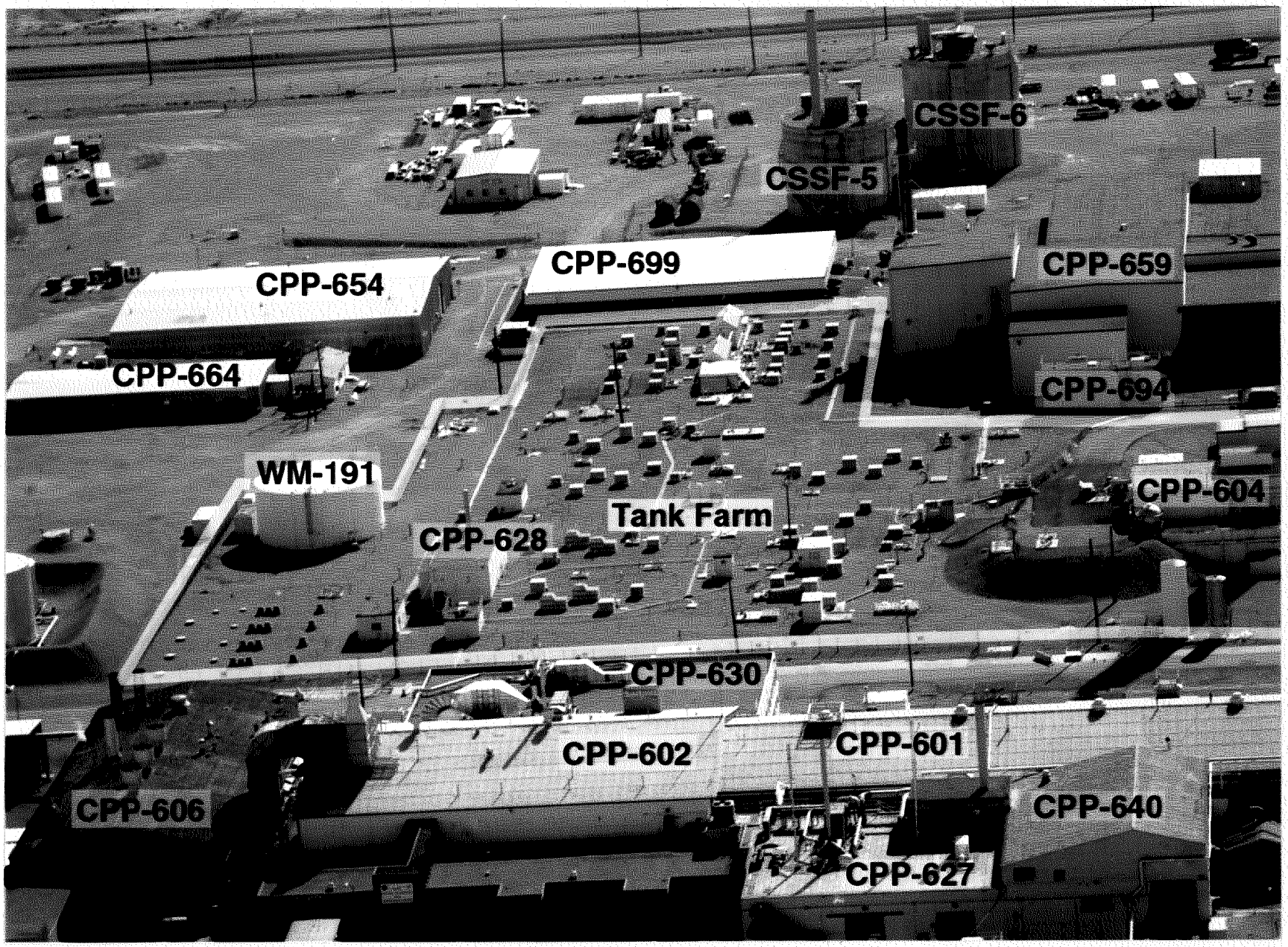

Figure 2-2. Aerial view of the Tank Farm (LMITCO 1998b).

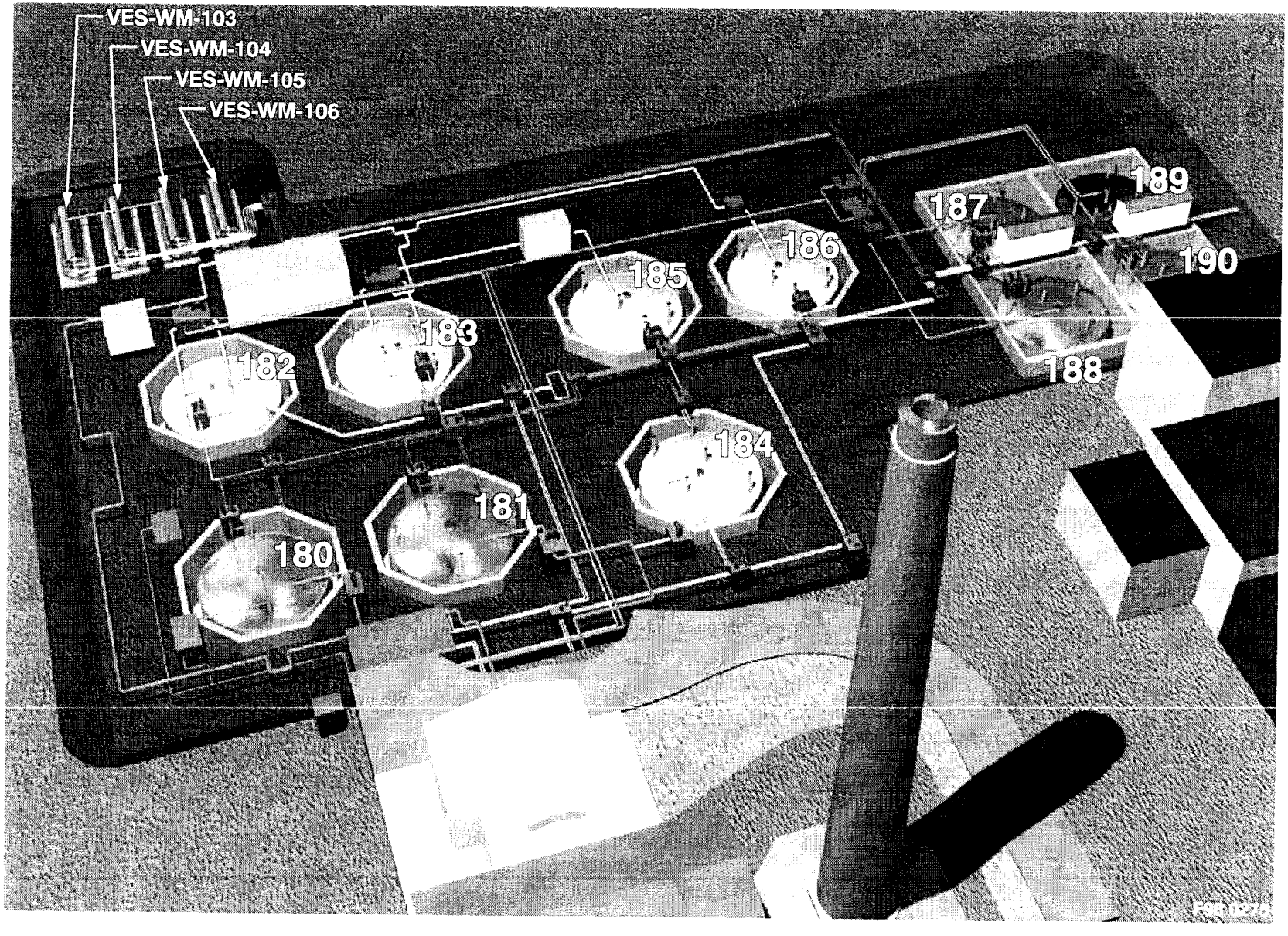

Figure 2-3. Conceptual view of the Tank Farm.

The environmental impacts of storage of the HLLW at INTEC are addressed in the High-Level Waste & Facilities Disposition Environmental Impact Statement (HLW & FD EIS) in accordance with National Environmental Policy Act (NEPA) (42 USC 4321 et seq.) requirements.

2.1.1 Current Operational and Regulatory Status of the Tank Farm

The current DOE mission for INTEC includes management and storage of SNF, and treatment and storage of high-level waste and sodium–bearing waste, generated during past SNF reprocessing, and treatment and storage of low-level waste, generated primarily from decontamination and other operations. The current mission of the Tank Farm is storing waste generated from decontamination and ongoing INTEC operations such as off-gas treatment, laboratory operations, facility decontamination, equipment decontamination, and SNF storage.

The volume of sodium-bearing and newly–generated waste in storage at the Tank Farm is dependent on the quantity and type of work done at INTEC. Sodium–bearing waste is generated primarily from decontamination and from operations associated with laboratories, fuel basins, and closure activities. Recent volumes of the remaining waste in the Tank Farm are shown in Figure 2-4. About 1.3 million gal of waste is stored in the Tank Farm currently (BBWI 2000).

2.1.1.1 Calcination. From 1963 until June 2000, the liquid waste stored at the Tank Farm was solidified using calcination. Calcination is the process of converting liquid radioactive waste to granular solids. The liquid in the radioactive waste (primarily nitric acid) is evaporated and the dissolved metals and fission products are converted to metal salts and oxides. Each granule is about 0.3 to 0.7 mm in size. (Palmer et al. 1998; WINCO 1986a). The solids are then transferred for interim storage to stainless steel bins called the Calcined Solids Storage Facility (CSSF). Calcination typically reduces the volume of high-level radioactive liquid waste 2 to 10 times (Palmer 1998). Calcination reduces the volume of sodium–bearing waste 2 to 4 times. From September1982 until June 2000, calcination at the INEEL was performed at NWCF, which is currently in shutdown status, pending a decision by DOE (in the Idaho HLW & FD EIS and then the ROD) whether to repermit the facility for operation or to close it and use another type of treatment, such as chemical separations or vitrification.

A small amount of liquid waste from the calcination process was then sent to the PEW for evaporation. The overheads from the PEW were sent to the Liquid Effluent Treatment and Disposal Facility (CPP-1618) and released out the INTEC main stack (CPP-708) and the concentrates (or "bottoms") were returned to the Tank Farm or to NWCF for storage to await use in a future calcination campaign. During the most recent operations, NWCF operated at a higher temperature than previously, about 600°C, instead of 500°C. Operation at the higher temperature required smaller quantities of chemical additives, thereby allowing a quicker net reduction of the liquid waste stored at the Tank Farm.

2.1.1.2 Tank Heels. Since the 1998 calcination of all HLLW at the Tank Farm was completed, all waste remaining at the Tank Farm has been considered sodium-bearing waste. Some of the heels have been flushed, with the exception of the 13,600-gal heel in Tank WM-188 (Palmer et al. 1998; BBWI 2000) (see Figure 2-4). The heel of Tank WM-188 is to be flushed with the sodium–bearing waste currently remaining in other 300,000-gal tanks.

The second modification to the consent order (DOE-ID 1998) stipulates that DOE must cease using five of the 300,000-gal tanks (WM-182, WM-183, WM-184, WM-185, and WM-186) by June 30, 2003, although the consent order allows WM-185 to be used as an emergency spare if it can be shown to meet the RCRA requirements and have a PE sign off that the tank is useable. The second modification requires ceasing use of the remaining six 300,000-gal tanks (WM-180, WM–181, WM–187, WM–188, WM-189, and WM–190) by December 31, 2012. A tank is considered to meet the cease-use requirement if it has been emptied down to its heel.

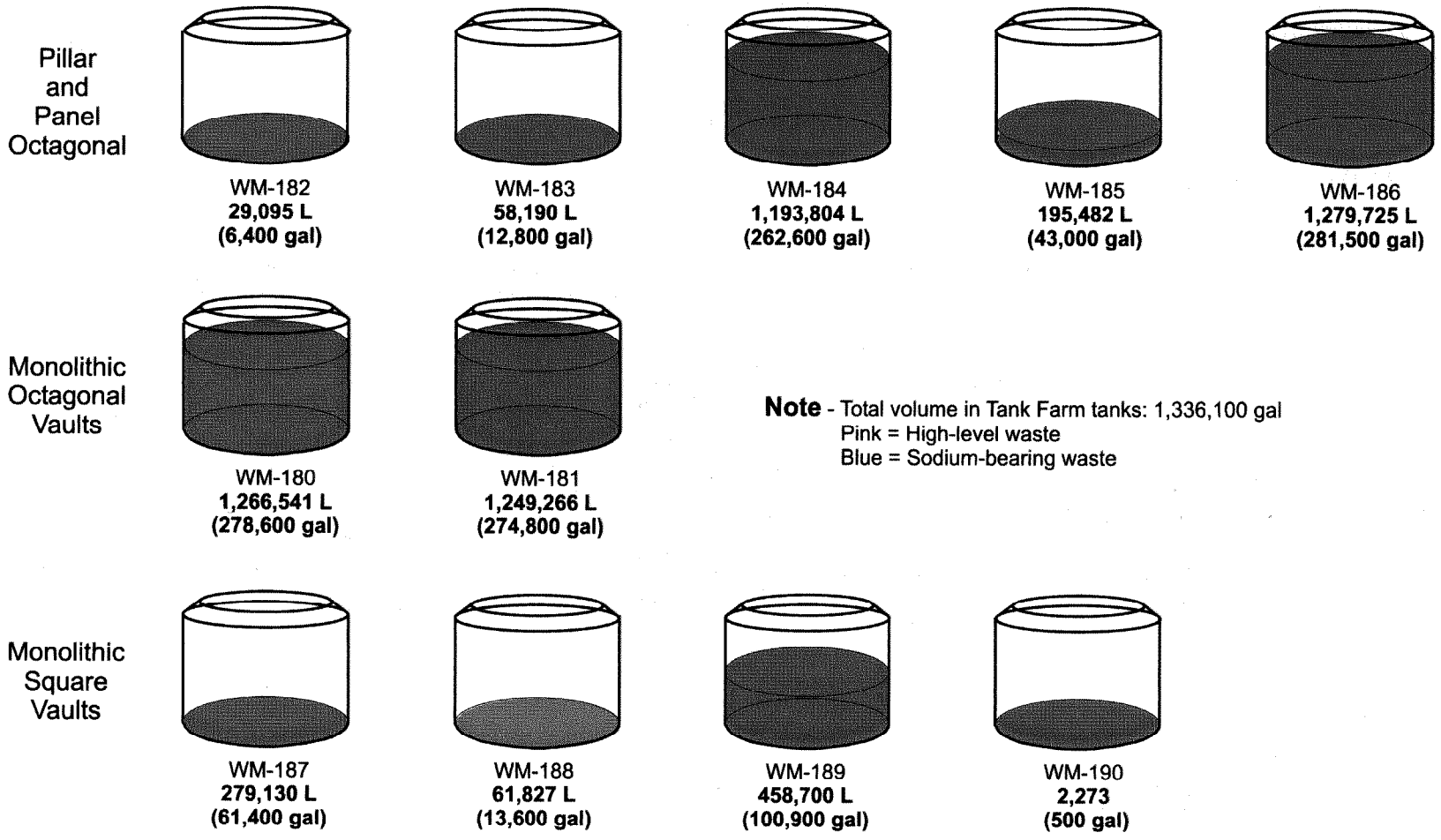

Figure 2-4. Recent Tank Farm volumes (300,000-gal tanks) (BBWI 2000).

A heel is defined as the liquid volume remaining in the tank after it has been reduced to the greatest degree possible with existing tank transfer equipment (Rasch 1994). The tanks are anticipated to be closed in groups to facilitate plant operations until alternate facilities are available. The second modification also requires the submittal of a closure plan for one 300,000-gal tank to the State of Idaho by December 31, 2000. Tanks WM-182 and WM-183 are to be the first tanks closed.

The heels of WM-188 and the first two tanks slated for closure, WM-182 and WM-183, have been physically evaluated for RCRA characteristics using the remote Light Duty Utility Arm (LDUA). The evaluation of the heel of WM-188 was performed in February 1999 and the heels of WM-182 and WM-183 were performed in late 1999 and January 2000. Based on the evaluations, the depth of solids that will be left in the tanks after closure is now estimated to average as much as 4 in. per tank, varying by as much as 3 to 10 in. Previous estimates were that an average of a 1-in. heel would be left in each tank. The total volume of all of the 300,000-gal tank heels, after removal of as much of the precipitated solids as possible with existing technology, is now estimated at 50 tons or 3% of the current volume.[a]

New instrumentation is being evaluated to attempt to further reduce the size of the heels. The use of high-pressure water from a wash ball or similar high-pressure nozzle or nozzle arrangement to wash the tank walls and agitate the tank heels is to be evaluated for the closure of Tanks WM-182 and WM-183. The size of the heel is also expected to vary for cease-use qualification for each tank depending on the conditions of the tank (Quigley 1999). The suction leg of the steam jet, which is the existing equipment used to drain the tank contents, may have varying effectiveness in each tank depending on the tank conditions, and certainly will be set at varying heights depending on the depth of the heel for each tank. The closure plans for each group of tanks will address the specific remaining tank heels (DOE-ID 1998).

2.1.1.3 Composition. All of the liquid waste in the 300,000-gal tanks has been sampled, and the general chemical and radionuclide compositions have been determined (Palmer et al. 1998). However, as stated in Section 2.1.1.2, only WM-182, WM-183, and WM-188 have been sampled for RCRA characteristics. High-level liquid waste was typically 1 to 3 *M* nitric acid-containing fission products, TRU elements, and metals such as mercury and cadmium. The maximum radioactive concentration in the 300,000-gal tanks was in the range of 10 to 20 Ci/L. Recent concentrations of chemicals and radionuclides in each of the 300,000-gal tanks are provided in Table 2-1 and 2-2.

2.1.1.4 Tank Description. The following underground storage tanks at the Tank Farm have been designated with interim status for regulation under the HWMA/RCRA:

- Eleven active tanks with a capacity of about 1,363,828 L (300,000 gal). The tanks include nine 300,000-gal tanks (WM-182 through 190) and two 318,000-gal tanks (WM-180 and 181). These 11 tanks are referred to collectively as the 300,000-gal tanks.

a. Information provided by E. P. Wagner, Jr., to P. A. Tucker in telephone interview, May 25, 2000, Bechtel BWXT Idaho, LLC.

Table 2-1. Estimated chemical properties and concentrations in 300,000-gal tanks (from Palmer et al. 1998).

Analyte or Constituent	Unit	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Density	g/mL	1.28	1.16	1.23	1.24	1.27	1.28	1.18	1.16	1.32	1.31	NR[a]
Acid [H^+]	M	1.20	1.89	0.85	2.03	0.45	1.61	1.57	1.98	2.79	2.62	0.02
Nitrate	g/L	298.65	239.98	264.16	342.30	301.99	328.03	190.99	208.97	3.82	401.20	1.24
Aluminum	g/L	17.81	6.21	33.99	17.54	22.93	19.43	9.98	14.57	23.47	28.06	NR
Boron	g/L	0.12	0.17	0.10	0.15	0.08	0.19	0.23	0.14	0.42	0.29	NR
Cadmium	g/L	0.09	0.62	0.023	0.17	0.02	0.22	0.20	0.58	1.07	0.67	NR
Calcium	g/L	1.44	1.84	NR	1.76	0.48	2.85	2.65	1.72	6.25	3.85	NR
Chloride	g/L	1.16	0.57	0.037	0.41	1.61	1.12	0.75	0.08	0.55	0.78	0.01
Chromium	g/L	0.21	0.16	0.05	0.88	0.10	0.26	NR	0.10	0.68	0.31	NR
Fluoride	g/L	0.08	1.79	1.60	1.06	0.80	3.19	0.80	4.41	6.04	6.65	0.13
Iron	g/L	1.06	0.73	1.17	3.41	1.17	1.23	1.06	1.12	3.13	1.95	NR
Lead	g/L	0.31	0.23	NR	0.33	0.25	0.21	NR	NR	0.25	NR	NR
Manganese	g/L	NR	0.77	NR	0.77	0.49	1.10	NR	NR	NR	NR	NR
Mercury	g/L	0.21	0.10	NR	0.56	0.32	0.82	NR	0.16	1.56	0.72	NR
Molybdenum	g/L	NR	0.05	NR	0.07	0.05	0.05	NR	NR	NR	NR	NR
Nickel	g/L	0.10	0.08	NR	0.43	0.08	0.09	NR	NR	0.33	NR	NR
Phosphate	g/L	NR	0.57	NR	NR	2.37	0.28	NR	NR	0.04	NR	NR
Potassium	g/L	7.43	5.87	0.12	3.91	5.47	7.82	6.65	0.78	5.87	5.87	NR
Sodium	g/L	48.51	21.84	0.46	18.62	48.51	33.80	23.22	4.14	17.93	26.21	NR
Sulfate	g/L	3.27	2.40	2.79	6.63	7.20	4.32	3.36	1.06	3.55	2.98	NR
Zirconium	g/L	< 0.11	0.46	1.00	< 0.15	NR	0.91	NR	2.19	2.46	2.92	NR

a. NR means not reported.

Table 2-2. Estimated radionuclide concentrations (Ci/L) in 300,000-gal tanks (Palmer et al. 1998).

Radionuclide	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Am-241	5.59E-04	2.08E-04	5.02E-04	7.48E-04	2.20E-04	5.59E-04	2.10E-04	4.58E-04	1.42E-03	9.14E-04	NR
Ce-144	NR	1.80E-06	2.01E-05	9.26E-07	NR	1.81E-06	1.11E-06	NR	NR	NR	4.52E-11
Co-60	NR	2.61E-04	1.22E-04	1.45E-04	NR	3.79E-05	5.02E-05	4.59E-05	3.52E-04	1.10E-04	NR
Cs-134	9.03E-04	2.33E-04	2.22E-03	3.43E-04	1.66E-06	1.16E-04	1.16E-04	1.72E-04	1.23E-03	5.40E-04	9.80E-07
Cs-137	2.85E-02	2.94E-02	5.67E-01	2.28E-01	2.02E-02	1.08E-01	3.25E-02	7.40E-02	3.74E-01	1.61E-01	1.06E-02
Eu-154	5.59E-05	2.99E-04	4.44E-03	9.26E-04	NR	2.48E-04	1.38E-04	3.66E-04	1.83E-03	7.30E-04	2.94E-05
Eu-155	NR	9.49E-05	1.14E-03	4.29E.04	NR	NR	NR	1.04E-04	6.36E-04	1.30E-04	4.08E-06
H-3	2.35E-05	2.11E-05	7.76E-04	4.82E-04	NR	3.58E-05	NR	NR	NR	NR	NR
I-129	< 1.4E-08	< 3.3E-07	NR	< 1.2E-05	5.72E-06	< 3.9E-05	NR	NR	NR	NR	NR
Ni-63	2.67E-05	6.22E-05	NR	NR	NR	NR	NR	NR	NR	NR	NR
Np-237	4.34E-07	1.93E-07	2.16E-06	7.72E-07	4.60E-07	1.44E-05	2.90E-07	5.67E-07	1.61E-06	1.11E-05	NR
Pu-238	3.47E-04	6.15E-04	2.57E-03	6.59E-04	6.59E-04	8.39E-04	2.32E-04	1.99E-03	3.77E-03	2.82E-03	NR
Pu-239	5.65E-05	1.30E-05	2.85E-04	2.40E-04	8.30E-05	7.52E-05	3.99E-05	1.04E-05	2.39E-04	6.62E-05	NR
Pu-240	1.69E-05	3.65E-06	1.64E-05	1.88E-05	3.40E-05	2.05E-05	9.86E-06	2.34E-06	2.11E-05	1.75E-05	NR
Pu-241	3.18E-04	2.75E-04	6.10E-04	5.61E-04	4.47E-04	9.08E-04	1.75E-04	8.69E-04	1.90E-03	1.63E-03	NR
Pu-242	1.27E-08	8.63E-09	1.94E-08	5.53E-08	1.00E-08	2.44E-08	4.17E-09	5.93E-09	6.05E-08	2.43E-08	NR
Ru-106	NR	5.58E-06	2.81E-05	NR	NR	1.67E-06	2.12E-06	NR	NR	NR	NR
Sb-125	NR	8.96E-05	NR	NR	NR	NR	3.09E-05	NR	NR	NR	NR
Sr-90	2.30E-02	2.82E-02	5.51E-01	1.75E-01	1.56E-02	9.59E-02	3.03E-02	NR	2.84E-01	NR	NR
Tc-99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
U-234	5.61E-07	8.53E-07	1.98E-06	6.28E-07	8.23E-07	1.31E-06	9.77E-07	3.16E-08	6.39E-07	9.85E-07	NR
U-235	1.54E-08	2.14E-08	5.73E-08	2.65E-08	2.26E-08	2.74E-08	2.27E-08	7.11E-10	2.59E-08	2.07E-08	NR
U-236	7.36E-09	7.56E-08	2.13E-07	2.57E-08	1.43E-08	6.09E-08	5.85E-08	3.18E-09	2.97E-08	4.77E-08	NR
U-238	9.37E-09	2.11E-08	1.08E-09	3.00E-08	9.16E-09	2.47E-08	5.15E-08	2.08E-12	2.77E-08	1.80E-08	NR

a. NR means not reported.

- Four inactive tanks with a capacity of 140,929 L (31,000 gal) (WM-103 through WM-106). As shown in Figure 2-1, the four tanks are located north of WM-182. The four smaller tanks are referred to collectively as the 30,000-gal tanks.

2.1.1.4.1 300,000-gal Tanks—The eleven 300,000-gal tanks are similar in design. Each has a 50-ft diameter, an overall height of about 30 to 32 ft, and is contained in an unlined underground concrete vault. The vault floors are about 45-ft belowgrade. The three basic designs of the vaults are described below:

- Monolithic octagon. The two oldest tanks at the Tank Farm (WM-180 and WM-181) were constructed from 1950 to 1953 and are contained in poured-in-place monolithic octagonal concrete vaults. A photograph of the vault for Tank WM-180 is provided in Figure 2-5.

- Pillar and panel octagon. The five tanks contained in vaults of pillar and panel construction, (WM-182 through 186) were constructed from 1953 to 1957. A photograph of the vault for tank WM-182 is provided in Figure 2-6. A photograph of the vault and dome of tank WM-185, showing the precast concrete beams and concrete risers on top, is provided in Figure 2-7. Also octagonal, the pillar and panel vaults are of prefabricated construction. The pillar and panel design is considered the least structurally sound of the three basic designs and, therefore, are expected to be closed first, with the exception of tank WM-185, which has been designated as an emergency spare.

- Monolithic square. The four tanks contained in reinforced poured-in-place, monolithic square, four-sectioned (or "four-pack") concrete vaults (WM-187 through WM-190) were constructed from 1959 to 1965 (see Figure 2-8).

Each 300,000-gal tank in the Tank Farm has a different waste storage history that has impacted or may impact the removal of the remaining waste. A brief summary of each tank compiled from information contained in two 1998 reports (Palmer 1998; Palmer et al. 1998) is provided below. As stated in Section 2.1.1.2, the waste in all of the tanks, other than the heel of Tank WM-188, has been flushed. However, additional rinsing, flushing, and heel removal may be required during the closure process for each tank.

- Tank WM-180 was put in service in 1954 and stored high-level waste from reprocessing aluminum-clad SNF. The tank has been used only for storing sodium-bearing waste since 1972. The tank currently contains 1,266,541 L (278,600 gal) of sodium-bearing waste (see Figure 2-4). The high-level waste in the tank was calcined during 1966–67. Tanks WM-180 and WM-181 are the two oldest tanks at the Tank Farm.

- Tank WM-181 became operational in 1953 and was used as a service waste diversion tank until 1975. Since then, the tank has been used to store sodium-bearing waste and currently contains 1,249,266 L (274,800 gal) of sodium-bearing waste (see Figure 2-4). It has never been used to store first-cycle raffinate high-level waste.

- Tank WM-182 became operational in1956 to store high-level waste from reprocessing aluminum-and zirconium-clad SNF. The tank contains 29,095 L (6,400 gal) of sodium-bearing waste (see Figure 2-4). The volume comprises the final flush of the 13,366 L (3,600-gal) tank heel. The tank was emptied to heel level in 1993. This tank is the first planned for closure under the HWMA/RCRA by 2004.

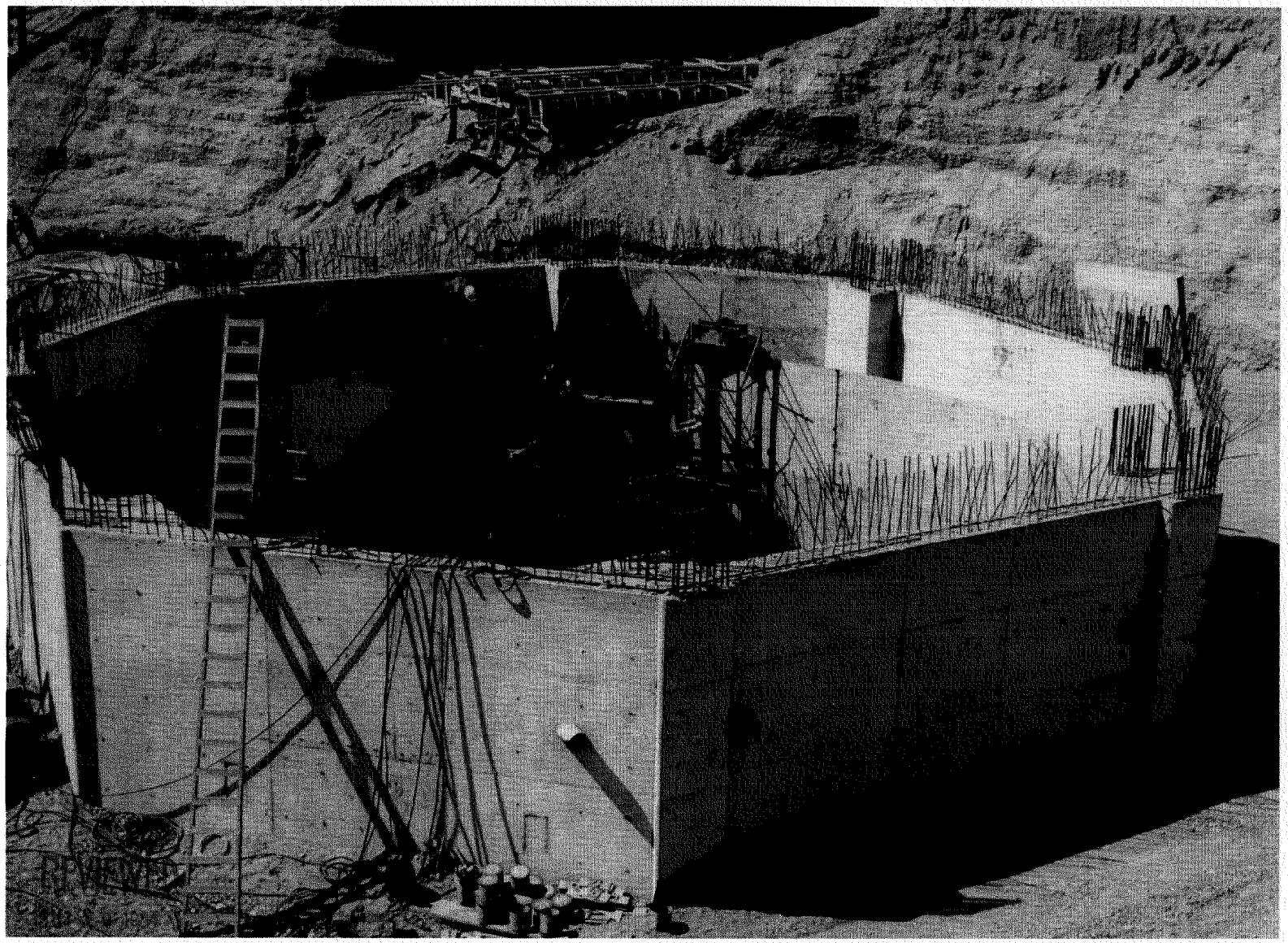

Figure 2-5. Monolithic octagonal vault for Tank WM-180.

Figure 2-6. Pillar and panel octagonal vault for Tank WM-182.

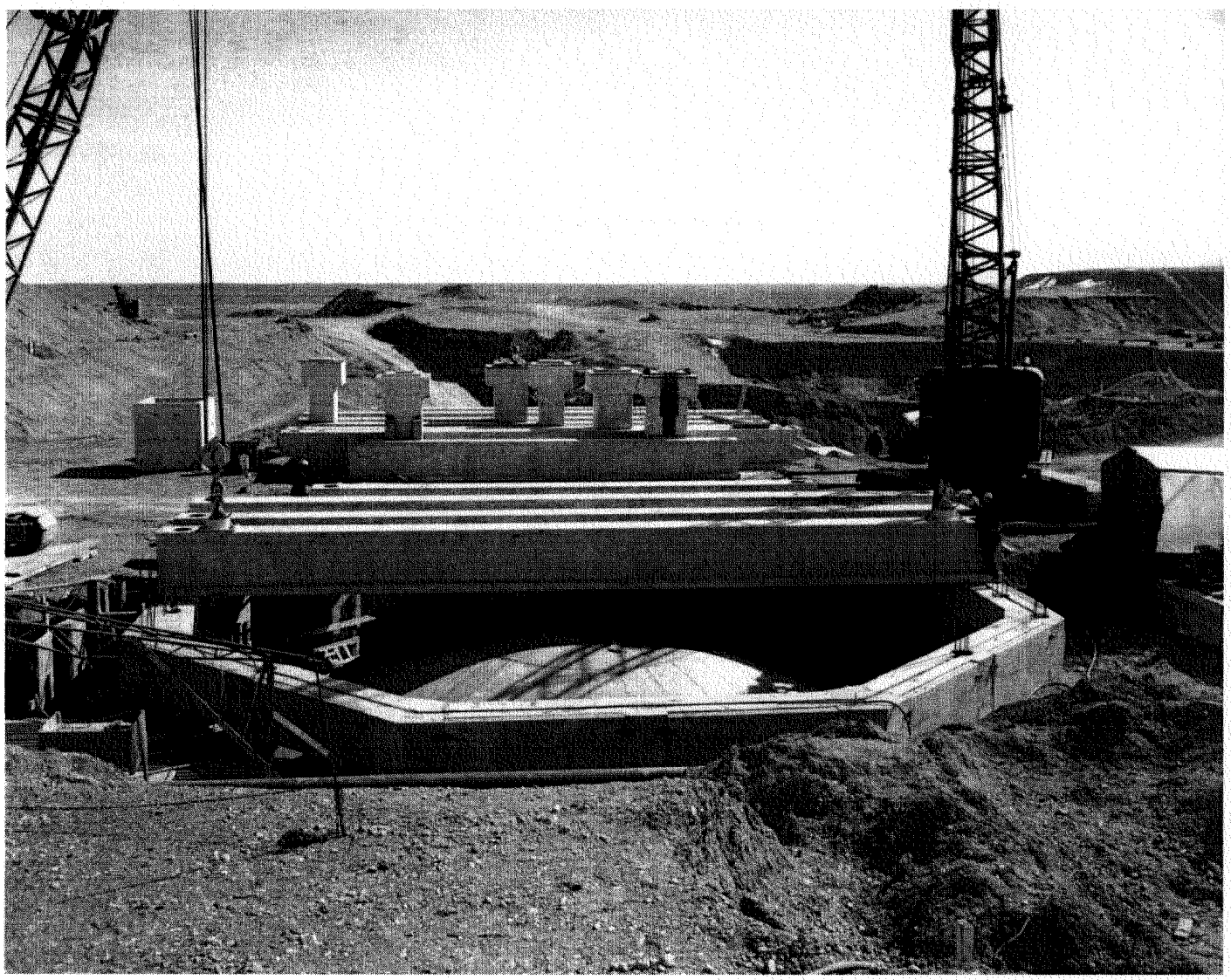

Figure 2-7. Vault and dome of Tank WM-185 showing the concrete beams and concrete risers on top.

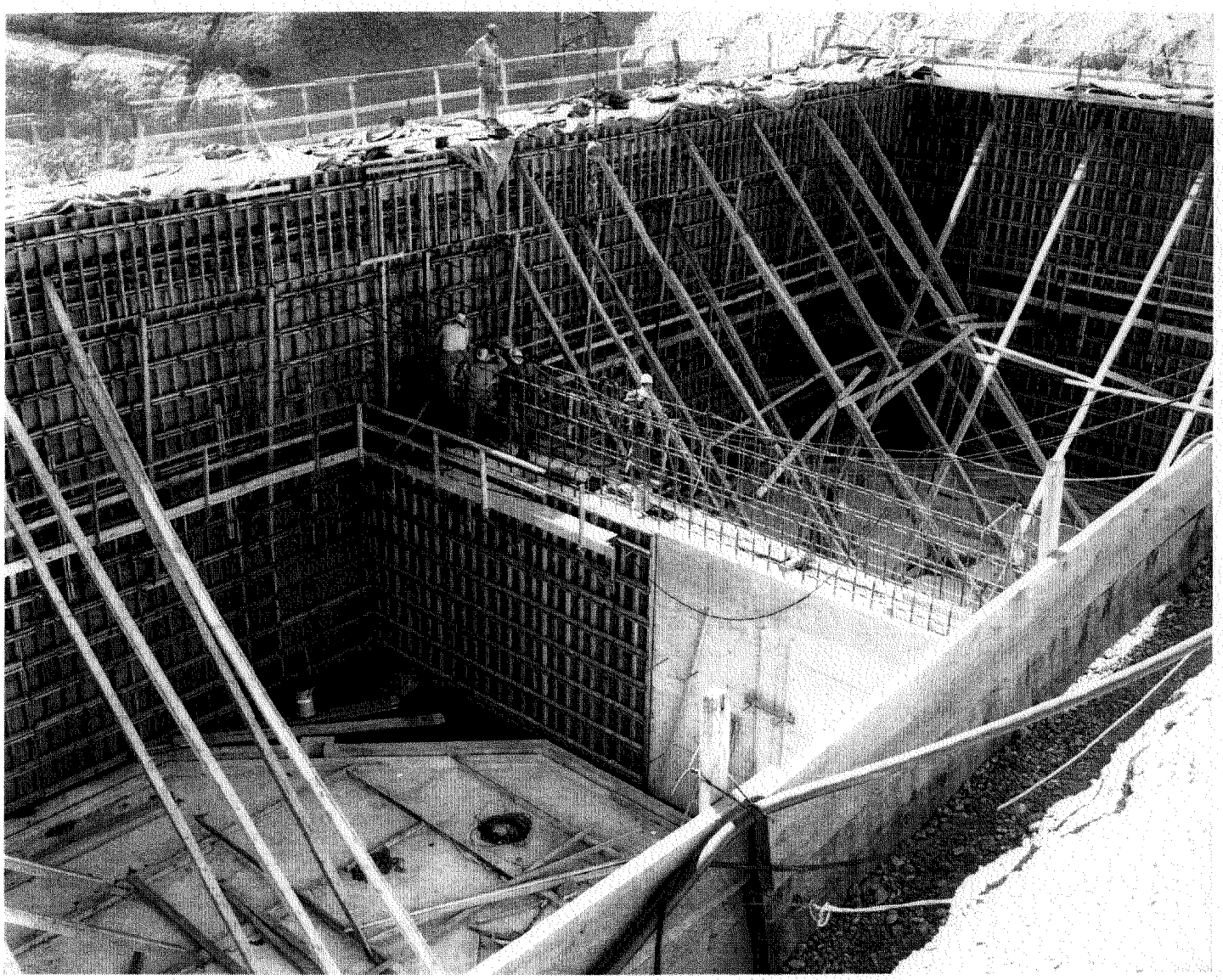

Figure 2-8. Monolithic square vault for Tank WM-190.

- Tank WM-183 became operational in 1958 and was originally used to store high-level waste from reprocessing aluminum- and stainless steel-clad SNF, high-fluoride decontamination solutions, and PEW evaporator and HLLW evaporator bottoms from the Waste Calcining Facility. The tank contains a heel of 58,190 L (12,800 gal) of sodium-bearing waste (see Figure 2-4). High-level waste was transferred from the tank in 1981, after which the tank was filled with sodium-bearing waste. Of all the tanks, WM–183 has contained the greatest variety of waste and its heel will likely have the most precipitated solids.

- Tank WM–184 became operational in 1958 and has contained only sodium-bearing waste composed of PEW Evaporator bottoms. The tank currently contains 1,193,804 L (262,600 gal) of sodium-bearing waste (see Figure 2-4). It has never contained first-cycle raffinate high-level waste.

- Tank WM–185 became operational in 1959 and has stored aluminum and zirconium fuel reprocessing waste, as well as high-fluoride decontamination waste and PEW evaporator bottoms. The tank currently contains about 195,482 L (43,000 gal) of sodium-bearing waste (see Figure 2-4). After it is emptied, the tank is expected to be used as a spare tank for emergency waste storage (LMITCO 1998a; DOE-ID 1998).

- Tank WM–186 was put into service in 1962 and contained high-level waste from reprocessing aluminum-clad SNF until 1967 when the high-level waste was transferred out of the tank. It currently contains 1,279,725 L (281,500 gal) of dilute sodium-bearing waste (see Figure 2-4).

- Tank WM–187 was put into service in 1959 and stored high-level waste from reprocessing of aluminum- and zirconium-clad SNF, high-fluoride decontamination waste, and PEW evaporator bottoms. The tanks currently contains 279,130 L (61,400 gal) of sodium-bearing waste (see Figure 2-4).

- Tank WM-188 became operational in 1963, and has contained zirconium fuel reprocessing waste as well as high-fluoride decontamination waste, and PEW evaporator bottoms. It currently contains approximately a 61,827-L (13,600-gal) heel (BBWI 2000) of high-level waste residue that has not been flushed (see Figure 2-4).

- Tank WM–189 became operational 1964 and contained high-level waste from reprocessing zirconium-clad SNF and waste from decontamination and bed dissolutions at the WCF and NWCF until 1996. The tank currently contains about 458,700 L (100,900 gal) of sodium-bearing waste and a heel of about 22,730 L. (5,000 gal) (see Figure 2-4).

- Tank WM–190 was never placed in service after it was constructed in 1964, but was retained as the designated spare tank for use in emergencies. It contains about 2,273 L (500 gal) of liquid waste (see Figure 2-4) remaining from approximately 31,823 L (7,000 gal) of accumulated meteoric (i.e., rainwater and snowmelt) vault sump water and liquid waste that leaked through closed valves and collected in the tank over time. The waste was pumped from the tank in 1982 using a sump pump that emptied the tank as much as possible without personnel entry.

A summary of the fuel processed and tank usage history is provided in Table 2-3.

Table 2-3. Types of fuel dissolution performed at INTEC (based on Wagner 1999).

Dissolution	Process Description	Facility	Campaign Dates	Comments
Aluminum (batch)	Aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Hexone was used as the uranium solvent for first-, second-, and third-cycle extraction.	CPP-601	1953–71	The original dissolution performed in C- and D-cells. The equipment was removed in 1984.
Aluminum (continuous)	Aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Tributyl phosphate (TBP) was used as the solvent for first-cycle extraction, and hexone for second and third cycles.	CPP-601	1957–86	Was being prepared for operation when reprocessing was terminated. Was performed in G-cell.
Zirconium	Zirconium-based fuels were dissolved in hydrofluoric acid. TBP was used for first-cycle extraction, and hexone for second and third cycles.	CPP-601	1957–81	The system was refurbished in 1986, but not used. To reduce the waste volume, the aluminum and zirconium dissolution processes were run together to eliminate the step of adding cold aluminum nitrate to complex fluoride.
Fluorinel (Fluorinel Dissolution Process [FDP])	Newer types of zirconium-based fuels were dissolved in hydrofluoric acid.	CPP-666	1986–88	Before the termination of reprocess, FDP was intended to be the major method of dissolution at INTEC. Cadmium nitrate was used as a nuclear poison to prevent criticality.
Stainless Steel (Submarine Intermediate Reactor [SIR])	Stainless steel fuels were dissolved in sulphuric and nitric acid.	CPP-601	1959–65	
Stainless Steel (Electrical Dissolution Process [EDP])	Stainless steel fuels were dissolved in nitric acid while a direct electrical current passed through fuel.	CPP-640	1973–81	The run was terminated because of equipment failure.
ROVER	Graphite fuels were first burned in oxygen to reduce the graphite. The uranium materials were dissolved in hydrofluoric acid.	CPP-640	1965–84	Uranium-bearing material recovery was completed in the facility in 1998.
Custom	Other fuels, such as cermet-type, were dissolved in specially designed equipment.	CPP-627	1965–91	The final run was terminated because of equipment damage.

2.1.1.4.2 30,000-gal Tanks—The four inactive 30,000-gal tanks (WM-103 through WM-106) were constructed in 1954 and are stainless steel belowground tanks on reinforced concrete pads. The tanks have a diameter of about 3.5 m (11.5 ft) and are 11.6 m (38 ft) long and covered by compacted gravel. Like the 300,000-gal tanks, the 30,000-gal tanks do not have secondary containment that can be certified to meet HWMA/RCRA requirements. Unlike the 300,000-gal tanks, the 30,000-gal tanks do not have vaults. The 30,000-gal tanks were emptied to their heels and taken out of service in 1983. Raw water was added to the tanks in 1990 to provide enough solution to sample for RCRA characteristics and radionuclides. The tanks were tested for pH, metals, and organics. The pH results ranged from 3.4 to 7.9 (WINCO 1990a, 1990b, 1990c, 1990d), the RCRA characteristics were determined to be nonhazardous (Matule 1990), and the radiation readings ranged from 6 to 35 mrem/hour (Machovec 1999, 1990). The tanks were then emptied to their heels, and the contents were used to flush lines from the Tank Farm to the PEW in CPP-604. While the inlets to the tanks were later cut, the outlets are still operational, allowing tank decontamination (see Appendix F for details).

2.1.2 Closure of the Tank Farm System

The Tank Farm is currently operating under HWMA/RCRA interim status (LMITCO 1999b). As stated in Section 1.6.1, it is DOE's intent that as each tank system is successfully closed as a HWMA/RCRA interim status unit, the closed tank system will be evaluated in accordance with the OU 3-13 ROD and the agency-approved OU 3-13 Group 2 Closure Evaluation Criteria and Checklist (CEC&C), and added to OU 3-14.

To maintain plant and Tank Farm operations during the closure process, the tanks are foreseen to be closed in phases involving groups of two or more tanks. It is anticipated that as many as six phases could occur. It is expected that any residual tank contents would be covered with grout and then surrounded by a concrete shell. The void remaining inside the tank would then be filled with material as decided in the HLW & FD EIS ROD, such as either clean grout or low-level radioactive waste grout (Palmer et al. 1998).

2.1.2.1 HWMA/RCRA Closure of the Tank Farm System. The Tank Farm is a HWMA/RCRA-regulated interim status tank system (IDAPA 58.01.05.009 [40 CFR 265]) and will be closed following cessation of operations. In accordance with a signed consent order, a HWMA/RCRA closure plan for one tank must be submitted to the IDEQ by December 31, 2000 (DOE-ID 1998). Current plans call for the tank farm to be closed, using a phased approach with a grouping of two or more tanks in each phase; therefore, a HWMA/RCRA closure plan for closure of two tanks, WM-182 and WM-183, constituting Phase 1 of the Tank Farm closure, will be submitted to IDEQ by December 31, 2000. DOE's draft HWMA/RCRA closure plan recognizes that the contaminated soils in the tank farm are undergoing investigation by the CERCLA program and will not duplicate the efforts of the CERCLA investigation and any follow-on remediation actions for the contaminated soils.

The HWMA/RCRA closure performance standards for closure of the tank system will be identified in the IDEQ-approved HWMA/RCRA closure plan. Idaho Administrative Procedures Act (IDAPA) 58.01.05.009 (40 CFR 265.197) establishes that "at closure of a tank system, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components, contaminated soils, and structures and equipment contaminated with waste, and manage them as hazardous waste..." However, the regulations provide that "if the owner or operator demonstrates that not all contaminated soils can be practicably removed or decontaminated as required...then the owner or operator must close the tank system and perform post-closure care in accordance with the closure and post-closure care requirements that apply to landfills..."

The strategy that DOE has provided to IDEQ has identified the general approach for closure of the tank farm system. The planned approach would begin with removing the waste from the tanks and ancillary system, decontaminating the system components, sampling the residuals and performing a risk assessment on the residuals following waste removal. Upon meeting the performance criteria for waste removal and system decontamination in the approved closure plan, this phase of closure (the first two tanks) would then be completed by isolating the closed system to eliminate any future inflow into the tanks, ancillary equipment, or secondary containment. The current strategy calls for using grout to fill the void spaces. The purpose of this effort is to reduce the amount of contaminants remaining in the system, eliminate future inflows into the system, and reduce the risk to human health and the environment. Upon completing the partial closure (the first two tanks), as specified in the IDEQ-approved closure plan, documentation would be provided to IDEQ certifying the performance of the partial closure. This process would be followed for each phase.

DOE is also responsible for ensuring that the performance of the HWMA/RCRA closure of the tank farm system will also meet the requirements of DOE Order 435.1, "Radioactive Waste Management." This DOE Order requires that systems that have managed a radioactive waste are properly decontaminated and closed, based on their radioactive constituents and associated risks.

2.1.2.2 Phased Closure. A phased approach is foreseen for closure of the Tank Farm. Closure cannot commence until a WIR determination has been approved by DOE-ID. The following criteria were used to determine the phases of the closure:

- Closure of tanks contained in pillar and panel vaults is highest priority because the vaults provide the lowest margin of safety for secondary containment
- History of tank usage and expected composition of heels
- Tank Farm management and operational requirements
- Phased tank closures in groups of two or more for cost-effectiveness and minimization of operational impacts on the Tank Farm
- Accessibility, such as near the edge of the Tank Farm, for continued Tank Farm usage (LMITCO 1998a).

The closure of each 300,000-gal tank is anticipated to require as long as 2 years. However, the closure of each tank will begin at the start of the second half of the closure of the previous tank. The closure of WM-182 and WM-183, the first tanks slated for closure, is expected to begin by 2002. The entire closure process could take as long as 15 years, or the closure could be expedited by several years. According to INTEC waste processing, the closure could be completed by as soon as 2010.

As stated above, tanks WM–182 and WM-183 are anticipated for closure in Phase 1, reflecting the emphasis on closing tanks contained in pillar and panel vaults first. Tanks WM-184 and WM-186 are expected to be closed in Phase 2 because of their pillar and panel vault construction. Tanks WM–180 and WM–181 are presumed for closure in Phase 3 because they are the oldest of the monolithic vaulted tanks and are accessible (see Figure 2-3). The closure of the four 30,000-gal tanks, WM-103 through WM-106, is anticipated for Phase 4. These tanks are no longer used and have been flushed and emptied (Palmer 1998). There is currently no cessation of use or closure agreement in place for the 30,000-gal tanks, which will be closed, as necessary, during the closure of the 300,000-gal tanks to maintain a level workload. Phase 5 of the Tank Farm closure is presumed to include closure of the last tank contained in a pillar and panel vault, WM-185, which has been designated for use as a possible emergency spare,

followed by closure of the first two tanks contained in monolithic square vaults, WM-187 and WM-188. The final phase of the Tank Farm closure is expected to comprise the last two tanks contained in monolithic square vaults, WM-189 and WM-190.

2.2 Operational History of the Tank Farm

Historically, the Tank Farm tanks provided interim storage for highly radioactive liquid waste, generated during fuel reprocessing operations, and consisted of the following:

- The eleven 300,000-gal tanks, contained in concrete vaults, provided primary storage of high- level and sodium–bearing liquid waste, except Tank WM-190, which was designated as an emergency spare.

- The four 30,000-gal tanks were normally empty because they have no containment vaults. From 1957 to 1965, the tanks were used to temporarily store specific processing waste such as zirconium and stainless steel waste from the CPP-601 E-cell until compatibility of the waste with that in the 300,000-gal tanks was determined. Since 1965, they have been used on a backup or emergency basis with DOE-ID authorization.

Historical descriptions of the sources of waste stored at the Tank Farm are provided in the subsections below.

2.2.1.1 Fuel Reprocessing. The INTEC facilities were designed to reprocess highly enriched SNF from test and research reactors in the United States and foreign countries, and from U.S. Navy ship propulsion reactors. Fission products would build up in the fuel elements, used in the reactors. The fuel in these elements that was reprocessed typically contained highly radioactive fission products. The elements would sometimes require replacement when only 25% to 35% of the original U-235 was consumed during the reactor process. The remainder could be recovered and recycled. The Tank Farm provided interim storage for highly radioactive liquid waste generated during fuel reprocessing operations. The historical operations information is provided to support data gathering about the contaminant source terms within the Tank Farm. The majority of liquid waste stored in the Tank Farm was generated during progressively more refined processes performed at the fuel processing building (CPP-601) to extract uranium in first-, second-, and third-cycle extractions. The extraction processes typically would remove nearly all of the fission products from the uranium.

2.2.1.1.1 Fuel Dissolution—The primary step in reprocessing SNF at INTEC was fuel dissolution. The objective in all INTEC fuel dissolution processes was to produce a solution of uranyl nitrate for solvent extraction. The different types of fuel dissolution processes, known as "headend" operations, that were performed during INTEC reprocessing are shown in Table 2-3.

Most fuel dissolution processes were housed in one processing complex (i.e., CPP-601, the Remote Analytical Facility building [CPP-627], and the Headend Process Plant [CPP-640]) adjoined and interconnected to the laboratory support facility (CPP-602). Only the fluorinel dissolution process (FDP), which was located in the Fluorinel Dissolution Process and Fuel Storage (FAST) facility (CPP-666), was not housed in the processing complex.

From the FDP, a liquid uranium-bearing product stream was prepared for the solvent extraction processes. The stream would sometimes be prepared as a "feed" by (1) clarification by centrifuge to remove particulate, (2) adjustment of the chemical composition by adding aluminum nitrate to drive the U-235 to the organic phase from the aqueous feed stream, or (3) suppression of emulsions by adding gelatin. Xenon and krypton were completely released during fuel dissolution and were recovered, commensurate with demand (WINCO 1986a).

2.2.1.1.2 Fuel Extraction—By far, the greatest amount of fission-product waste at INTEC was contained in the liquid radioactive waste streams from the extraction processes. Liquid-liquid extraction is the process of separating one component of liquid mixture by contacting the mixture with an immiscible liquid in which the desired component has preferential affinity. In fuel extraction processes at INTEC, either the organic solvent hexone (methyl isobutyl ketone [MIBK]) or tributyl phosphate (TBP) in a kerosene diluent was put in contact with uranium in an aqueous solution of uranyl nitrate. The separation occurred when uranyl nitrate mass-transferred to the organic phase. Traces of fission products were scrubbed from the organic phase with a slightly basic aluminum nitrate solution. Mass transfer back to an aqueous phase was accomplished in a water solution containing less than 0.01 *M* nitrate ion.

Total separation of the uranium from other fission products was achieved in first-, second-, and third-cycle solvent extraction. The uranyl nitrate solution from the third cycle was converted to granular uranium oxide in a fluidized bed denitrator. The uranium oxide was then shipped to other government facilities for return to the nuclear fuel cycle. Because highly radioactive solutions were processed at INTEC, concrete walls up to 1.5 m (5 ft) thick were required for shielding. The total radioactivity of materials within some of the processing cells was routinely as high as 500,000 Ci, equivalent to the radioactivity of more than one-half ton of radium.

During the fuel dissolution and extraction processes, a series of cells from A-cell to Z-cell ("I" was not used as a cell designator), located in CPP-601, were used to extract uranium from the fission products in the SNF. The A- through D-cells were the original cells used in fuel dissolution. During the peak years of fuel reprocessing from 1972 to 1989, E-, F-, G-, and H-cells were used for first-cycle extraction. From the start of INTEC operations until the mid 1980s, product from the H-cell evaporator was sent to N-cell for intercycle storage. After the construction of the M-cell, the H-cell product was sent directly to the M-cell and then to the N-cell. The C-, J-, L-, and S-cells were used for uranium salvage and recycle systems. The H-cell was used to store and treat first-cycle solvent, and the K-cell was used for solvent cleanup. The L-, M-, and N-cells were used for intercycle storage. The O-, P-, Q-, R-, and S-cells were used for second- and third-cycle extraction processes. The T-cell was used for solvent storage for second- and third-cycle extraction, the V-cell housed a health physics office, the W-cell was used for solvent (hexone) collection and sampling for second- and third-cycle extraction, and the X-cell contained a laboratory facility. Final storage of uranyl nitrate was located in the Z-cell in nine tanks, each 133 mm (5-1/4 in.) in diameter by 5.18 m (17 ft) long with a capacity of 14.5 gal (66 L).

After 1965, the contents of only three cells (G-, U-, and Y-cells) were shipped directly to the Tank Farm for storage. Aqueous waste streams, or raffinates, from the second- and third-cycle extraction columns flowed by gravity to the U- and Y-cells, in which the waste was collected. The G-cell contained the waste stream from first-cycle extraction. The contents of the waste stream were either shipped directly to the Tank Farm through a line through U-cell for storage or sent back for further refinement. After a tank was filled, the contents were sampled for uranium content. Generally, based on sampling of the waste tank, if the uranium concentration of the waste stream exceeded 5.0E-02 g/L, the waste was recycled for second- and third-cycle extraction. When the uranium concentration was less than 6.0E-03 g/L, the waste was routed to the Tank Farm.

2.2.1.1.3 Raffinate—In general terms, raffinate refers to the liquid waste from refinement processes. In historical applications at the INTEC reprocessing facility, raffinate refers to the liquid waste products from the refinement of waste involved in first-, second-, and third-cycle reprocessing of SNF. The raffinates were separated into two categories:

- High-level waste from first-cycle extraction
- Sodium–bearing waste from second- and third-cycle extraction, which was blended with concentrated bottoms from the PEW evaporator.

The raffinate waste streams from INTEC reprocessing contained unwanted components after the liquid-liquid solvent extraction of uranium from other fission products in SNF. In liquid-liquid solvent extraction, one or more components are removed from a liquid mixture by intimate contact with a second liquid, which is itself nearly insoluble in the first liquid and dissolves and extracts the component that is to be purified, leaving the impurities in the first liquid (raffinate) (Bosley 1999).

The raffinates were maintained in an acidic state to ensure that all uranium and other salts were in solution. The acidity maintained in the raffinate streams prevented formation of chemical precipitates, which could cause undesirable reactions during interim storage.

2.2.1.1.3.1 First-Cycle Extraction—The first-cycle extraction process was performed by preferentially separating uranium from other fission products, through vigorous contact with the organic solvent hexone or TBP in a kerosene diluent, leaving behind the fission products. The solvent-uranium was brought into contact with a nitrate-deficient aqueous solution, and the uranium transferred into the aqueous solution.

The heart of the extraction process consisted of four pulsed, perforated-plate columns that successively (1) extracted uranyl nitrate from the aqueous to the organic phase; (2) scrubbed the organic phase to reduce carryover of fission products and nitric acid; (3) stripped the uranyl nitrate from the organic phase back to the aqueous phase in the absence of the nitrate ion; and (4) washed the aqueous phase with hydrocarbon diluent to minimize entrainment of TBP in the aqueous phase. In the first-cycle extraction process, the product, or uranium-containing stream, was processed through a series of four pulsed, perforated-plate columns and then through a product evaporator. Traces of the organic solvent were removed before the stream was concentrated in the evaporator. The removal was done in the washing column by a stream of hydrocarbon diluent. The uranium product was then concentrated in the evaporator and sent to M-cell for temporary storage and sampling, and then to N-cell for intercycle storage. Fuel would be processed in the first cycle until the intercycle storage was filled, normally in 6 – 12 months. The first-cycle process was shut down until all the uranium was processed through the second- and third-cycle extraction and converted to uranium trioxide. The uranium product was then packaged for shipment. After the mid-1980s, solvent and hydrocarbon diluent used in first-cycle extraction was decontaminated by steam distillation and the solution was transferred to a storage tank in CPP-694 near NWCF (CPP-659).

The chemical composition of HLLW generated during the first-cycle extraction process varied according to the type of fuels processed. The raffinates included fluoride-bearing waste from zirconium dissolution, from coprocessed zirconium and aluminum dissolution, and from nonfluoride waste from dissolution of stainless steel and aluminum fuel. All first-cycle raffinates were acidic with a hydrogen-ion concentration between 1 and 3 *M*. Typically, the waste was lifted to ground level by airlifts and then gravity fed to the Tank Farm. Liquid waste with significant concentrations of corrosive chemicals, such as sulfates and chlorides from various sources throughout INTEC was routed directly to the Tank Farm. Except for the tanks containing only sodium–bearing waste (WM–181, WM–184, and WM–190; which was designated as the emergency spare), high-level waste and sodium–bearing waste were stored within the same tanks (Staiger 1999).

The primary transfer route for first-cycle waste from the process areas to the Tank Farm was via two 3-in. lines (3"-PUA-2297Y, which was replaced in 1982 by 2"-PUAR-104853, and 3"-PUA-2401Y, which was replaced also in 1982 by 2"-PUAR-104854) to the surge transfer tank, WM-178, for possible transfer to eight of the eleven 300,000-gal storage tanks (Tanks WM-181 and -184 were reserved exclusively for sodium-bearing waste and WM-190, an emergency spare, was never used). Because the airlift for Tank WM-178 would entrain moisture droplets into the off-gas filter system, the raffinate siphon system was installed in the mid 1980s, which allowed bypassing of Tank WM-178. However, the gravity-vacuum system required the addition of wastewater to restart the system when the siphon would shut down. In 1986, the siphon system was replaced by steam jets, still bypassing WM-178. In 1992, the WM-178 tank lines were capped and the tank was abandoned in place because of a lack of secondary containment.

The first-cycle extraction waste streams, relatively high in radioactivity, were analyzed for uranium content. (During the early years of extraction, the waste was then evaporated, if possible, to reduce volume. However, the evaporation step was subsequently eliminated to avoid problems associated with clogging of the raffinate waste.) The concentrate was then transferred to a 300,000-gal storage tank with cooling coils (i.e., WM-180, -182, -183, -185, -187, -188, or -189 [WM-190 also was equipped with cooling coils but was designated as an emergency spare]). Waste from the second- and third-cycle extraction processes was concentrated and generally stored in one of three 300,000-gal tanks without cooling coils (WM-181, -184, and -186, which stored high-level waste only from 1959 to 1967). The waste from second- and third-cycle processing did not require controlled cooling. All HLLW was eventually calcined to a solid and stored in underground stainless steel bins, the CSSFs.

Hexone—From 1953, when reprocessing began, until the early 1960s, hexone, an organic solvent also used as a paint thinner and alcohol denaturant, was used to extract uranium from its fission products during first-cycle extraction. Hexone is flammable and slightly soluble. Slight losses to the raffinate waste streams occurred (about 0.02%) in waste stream shipments to the Tank Farm, the PEW evaporator, or the Tank Farm vessel off-gas system. During peak reprocessing of the second- and third-cycle extractions, two 55-gal barrels of hexone were used weekly. Fresh hexone was added to the system through the hexone solvent storage tank (YBD-106). Hexone was the only solvent used for second- and third-cycle extraction.

Tributyl Phosphate—During the early 1960s, TBP replaced hexone as the organic solvent in first-cycle extraction and was used in a kerosene diluent until reprocessing was terminated in 1992. First-cycle extraction became alternately known as the TBP extraction process. Unlike hexone, TBP meets the RCRA test for nonhazardous flammability and has extremely low solubility (less than 0.002%). Therefore, only small amounts were lost in the raffinate waste streams. In addition to uranium extraction, TBP is also used industrially as an antifoaming agent and a plasticizer.

2.2.1.1.3.2 Second- and Third-Cycle Extraction—In the second- and third-cycle extraction processes, the solvent, hexone, purified the uranium product from first-cycle extraction. The purposes of the second- and third-cycle extraction process were to (1) separate the uranium from residual fission products and TRU elements, such as neptunium and plutonium; (2) recover more than 99.999% of the uranium; and (3) transfer the waste material to storage in the Tank Farm.

Located in the P- and Q-cells, respectively, the second- and third-cycle extractions were two nearly identical extraction cycles. Product from hexone extraction was collected in the Q-cell for transfer to storage. Used hexone was then collected in W-cell (before 1985, also in Y-cell), purified, and recycled for reuse. The aqueous waste streams containing TRU and fission products were collected and transferred to the Tank Farm to await calcination.

Second-cycle raffinates were transferred to the Tank Farm via a 3-in. line (3"-PUA-2297Y, which was replaced in 1982 by 2"-PUAR 104853). Third-cycle raffinates were transferred to the 300,000-gal storage tank via a 3-in. line (3"- PUA-2401Y, which was also replaced in 1982 by 2"- PUAR 104854). After 1986, second- and third-cycle raffinates were mixed in U-cell and transferred to the Tank Farm via the Y-cell route.

Liquid wastes from various INTEC areas were transferred to the Tank Farm through underground stainless steel lines. The buried waste lines constituted two separate systems: one for the transfer of high-level liquid waste and one for sodium-bearing-level liquid waste. In the early 1980s, an electronic register system was developed for material batch transfers to avoid inadvertent transfers. The system provided information, such as the valve lineup and volume availability of a tank to receive a transfer.

2.2.1.2 Waste from Other Sources. While the largest volume of waste originated from fuel reprocessing in CPP-601, waste was shipped to the Tank Farm from several other facilities. The process flow of historical fuel operations at INTEC is illustrated in Figure 2-9. A map showing the facility sources of waste stored at the Tank Farm is provided in Figure 2-10.

Intermediate-level waste and low-level waste were sent to the PEW evaporator, and the PEW bottoms were then shipped to the Tank Farm for storage. The other types of waste shipped to the Tank Farm through the PEW and the facilities from which the waste was generated include the following:

- Fluoride- and cadmium-bearing waste from the FDP (from the FAST facility at CPP-666 through the Fuel Processing Facility CPP-601)
- Waste from the fuel storage basins (in FAST and the Fuel Storage Facility in CPP-603)
- Decontamination waste containing fluoride from the waste calcining process (from the WCF at CPP-633 and later the NWCF at CPP-659)
- Occasional transfers from tanks, WL-104 and WL-105, in the West Side Holdup Facility in CPP-641 and the Pilot Plant in CPP-637 and the Headend Process Plant in CPP-640
- CPP-684, the Remote Analytical Facility (RAF) in CPP-627, and the Analytical Laboratory in CPP-602
- Chlorinated solvents used for degreasing from maintenance operations from the Maintenance Hot Shop in CPP-663
- Non-INTEC waste such as from Test Area North (TAN) or Test Reactor Area (TRA) through the numerous truck unloading stations, such as CPP-1619, at the INTEC
- Decontamination and other incidental waste from the Liquid Effluent Treatment and Disposal Facility in CPP-1618.

Of those facilities, FAST (CPP-666), the Fuel Processing Facility (CPP-601), the WCF (CPP-633), the Pilot Plant (CPP-637), the Headend Process Plant (CPP-640), the RAF (CPP-627), and the Hot Shop (CPP-663) are inactive. These facilities are, or will be, decontaminated, dismantled, and closed.

All hazardous waste was analyzed before it was processed to ensure compatibility with equipment in the raffinate streams. Liquid waste was segregated according to chemical composition and stored in separate vessels. When space was limited, waste was combined if analysis determined an undesirable chemical reaction would not occur.

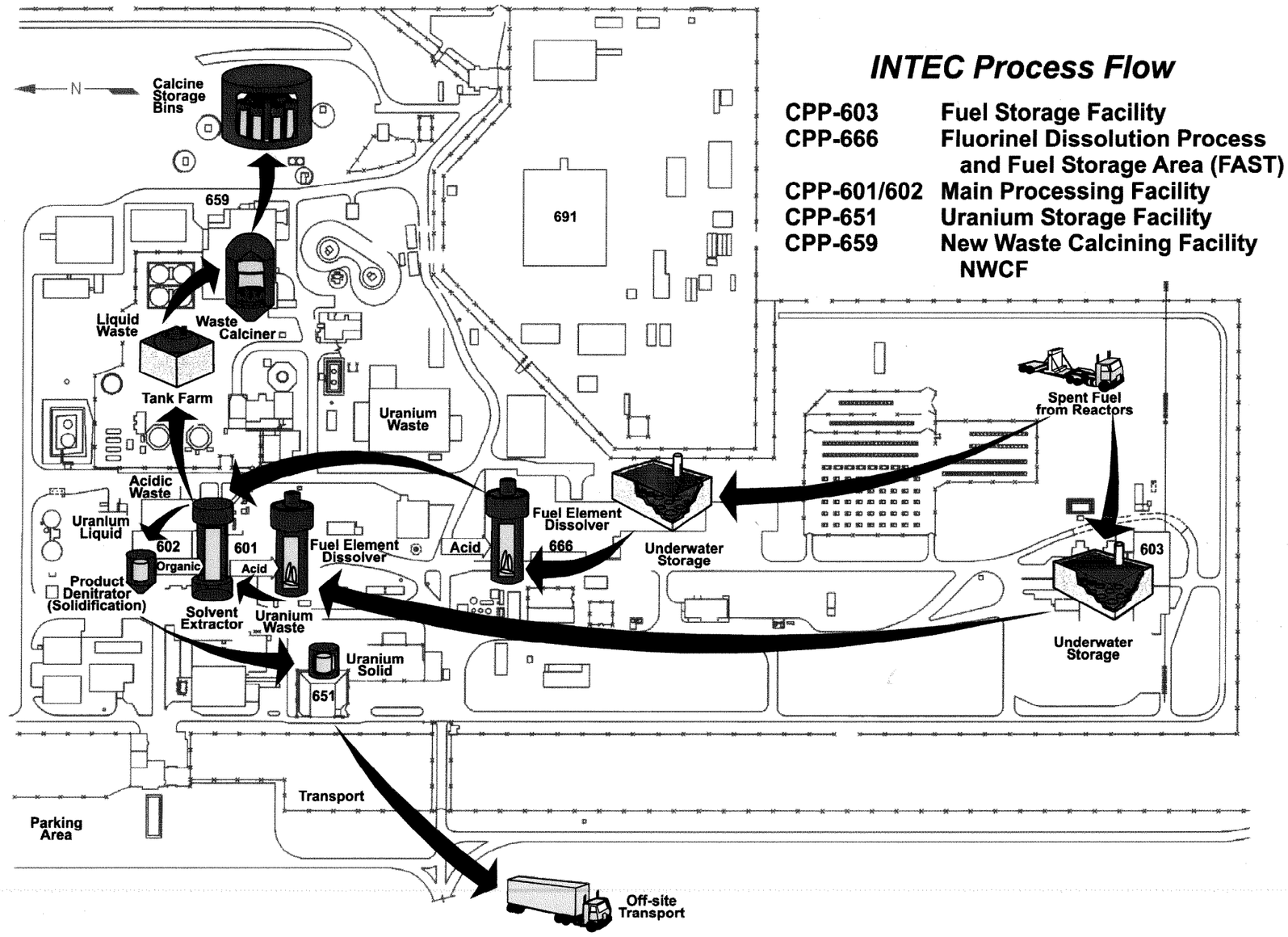

Figure 2-9. The process flow of historical fuel operations at INTEC.

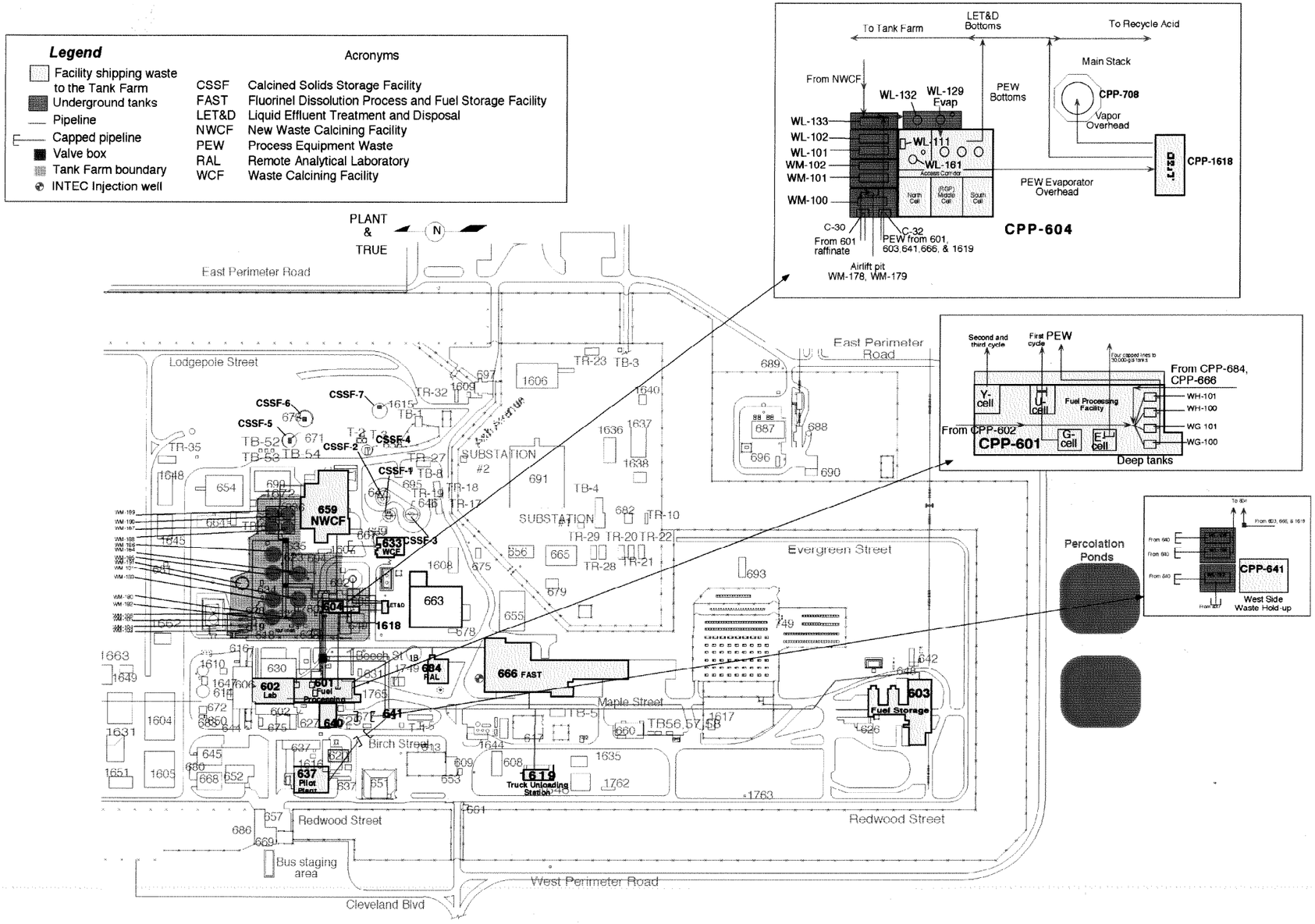

Figure 2-10. Facility sources of waste stored at the Tank Farm.